

# Two-color and multistatic space debris laser tracking

## 20th Int. Workshop on Laser Ranging

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*3 Austrian Academy of Sciences, Space Research Institute, Graz*

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Knowledge for Tomorrow



# Space Debris Sources

- 17729 objects cataloged by U.S. Space Surveillance Network (5th July 2016)
- ca. 8% operational satellites
- Threat for manned space flight and active satellites

Spacecrafts  
(22%)



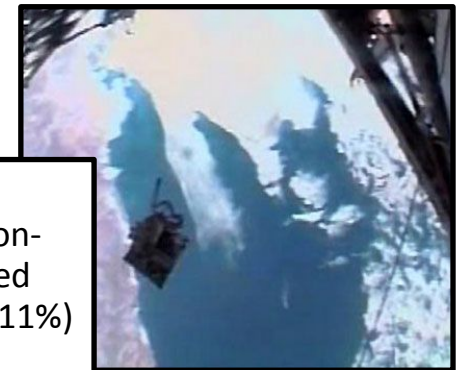
Fragmen-  
tation Debris  
(56%)



Rocket Bodies  
(11%)



Mission-  
related  
Debris (11%)

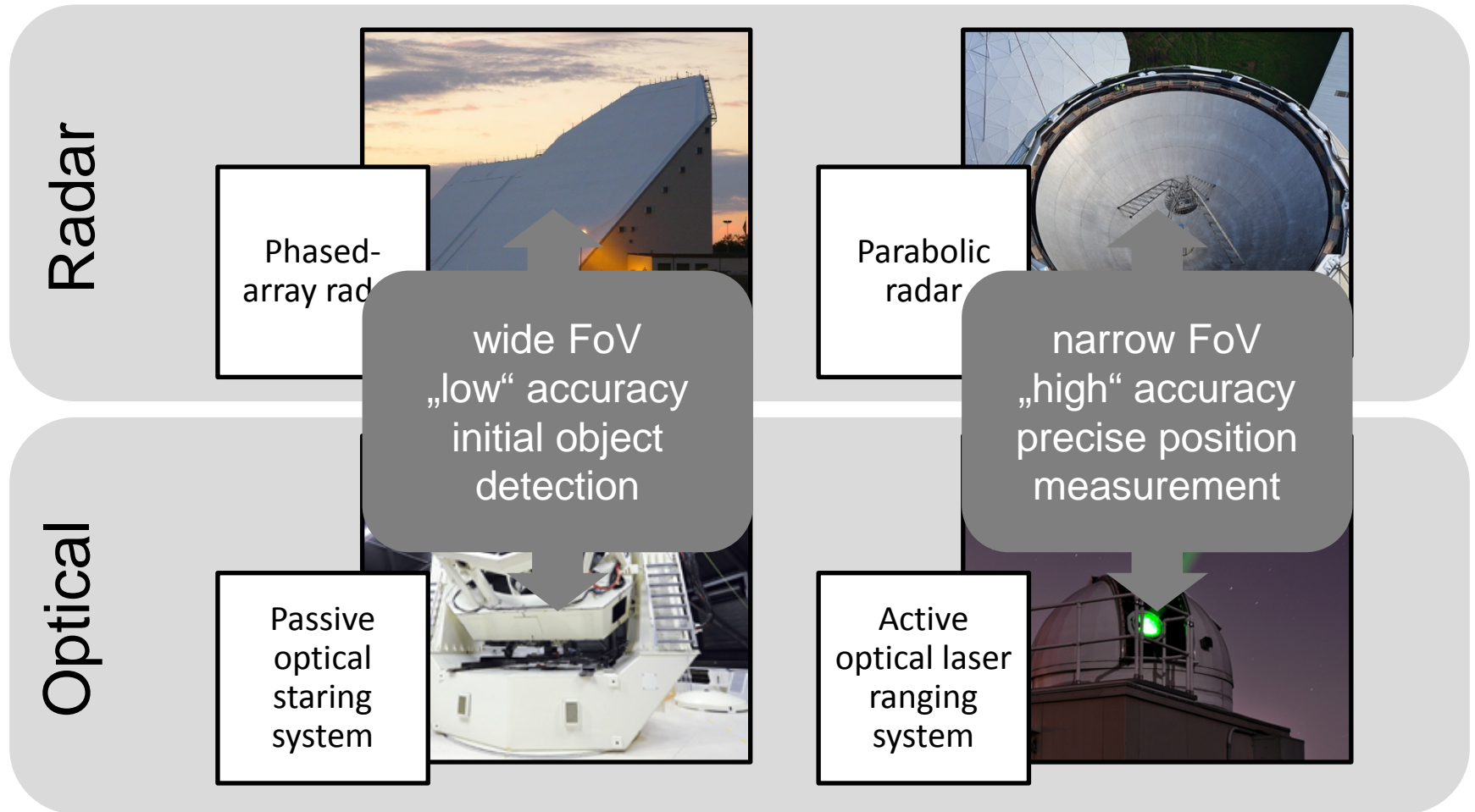


*Orbital Debris Quarterly News Vol. 20, Issues 1&2, April 2016;* <http://orbitaldebris.jsc.nasa.gov/>

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UCS Satellite Database, data from September 2016 <http://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database>

# LEO Space Debris Tracking





# Radar

Phased-  
array radar



Parabolic  
radar



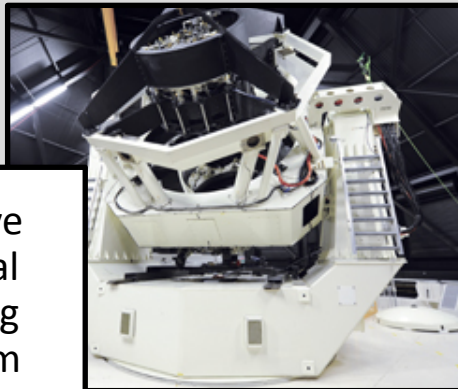
+ wavelength  $\ll$  object size  $\Rightarrow$  no Rayleigh behavior for small objects

+ narrower beam (better  $\lambda/D$ )  $\Rightarrow$  higher angular accuracy

+ signal strength independent accuracy  $\Rightarrow$  high accuracy for small objects

# Optical

Passive  
optical  
staring  
system



Active  
optical laser  
ranging  
system

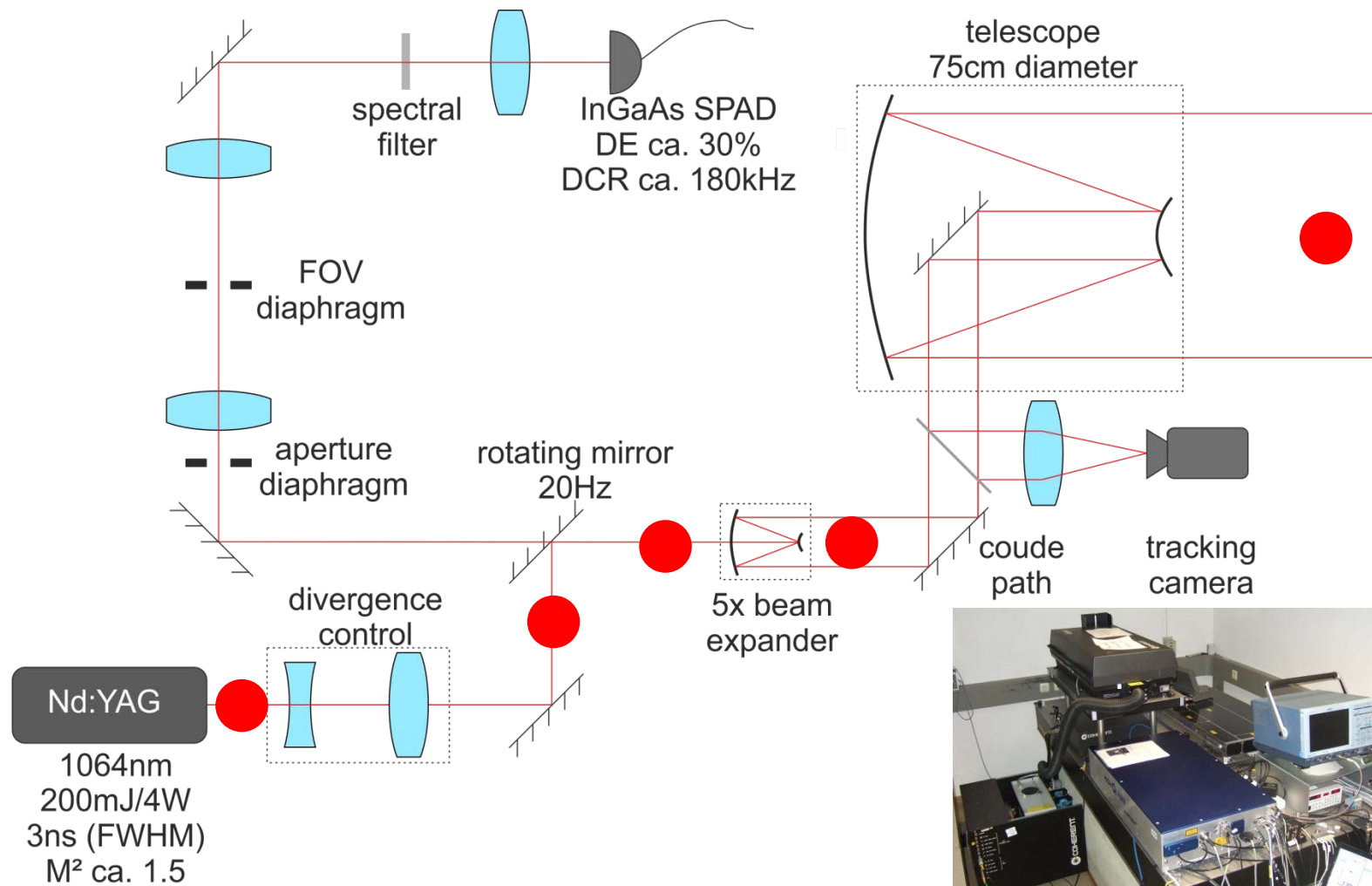


# ESA GSTP Project „Accurate orbit determination of space debris with laser tracking/tasking“

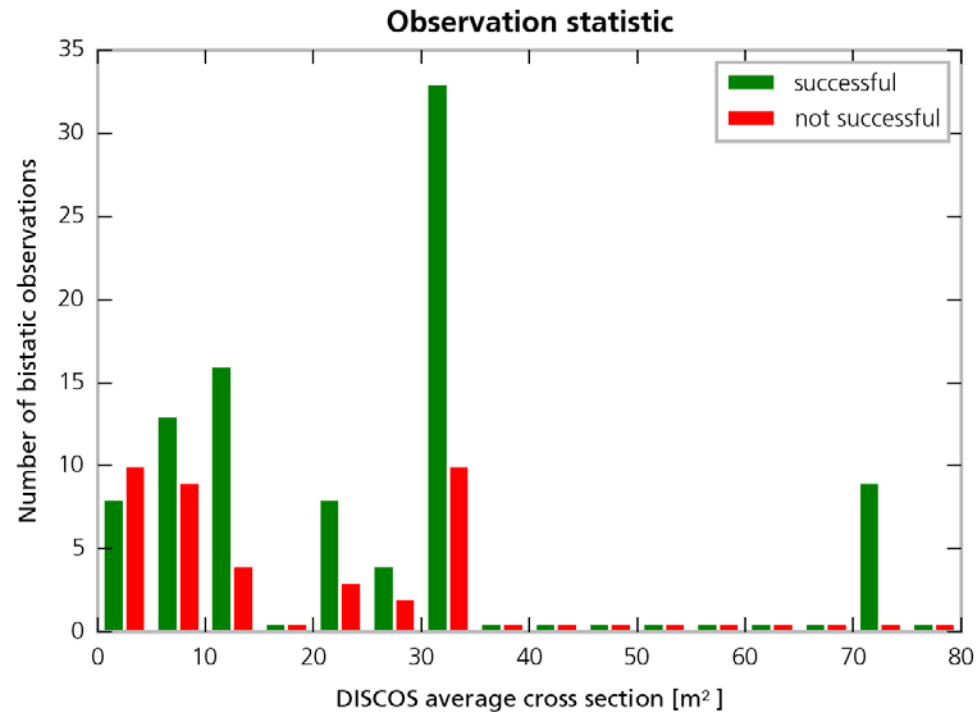
- Tasks:
  - Upgrade SLR station Wettzell to a debris laser ranging (DLR) station
  - Perform standard two-way ranging to space debris
  - Perform bi- and multistatic measurement campaigns
  - Evaluate achievable orbit quality of the different configurations
- Participants:
  - German Aerospace Center Stuttgart (DLR)
  - Technical University Munich (TUM)
  - Space Research Institute Graz (IWF)



# Upgrade Wettzell SLR Station to DLR Station



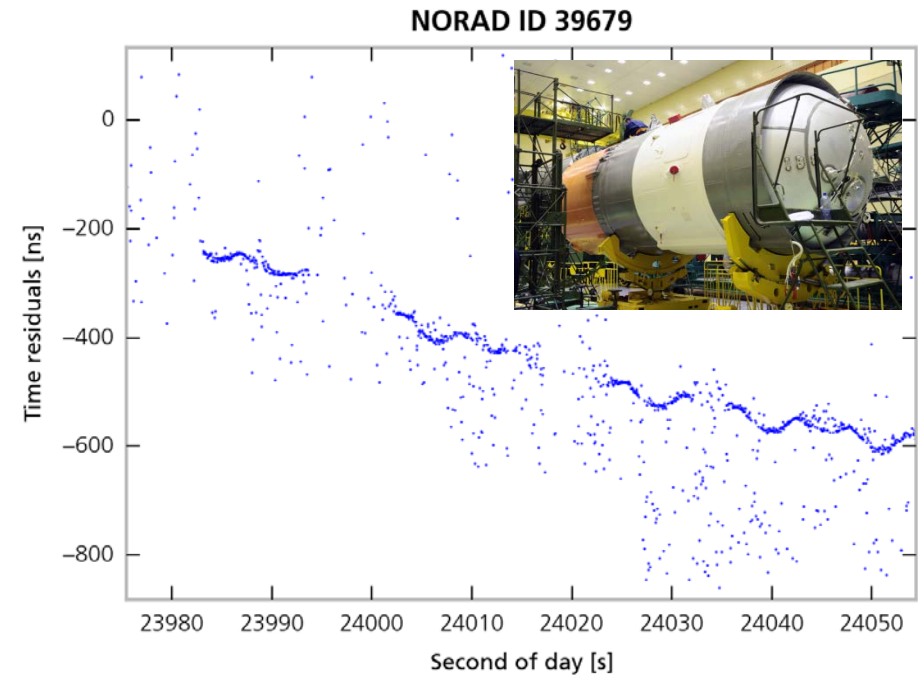
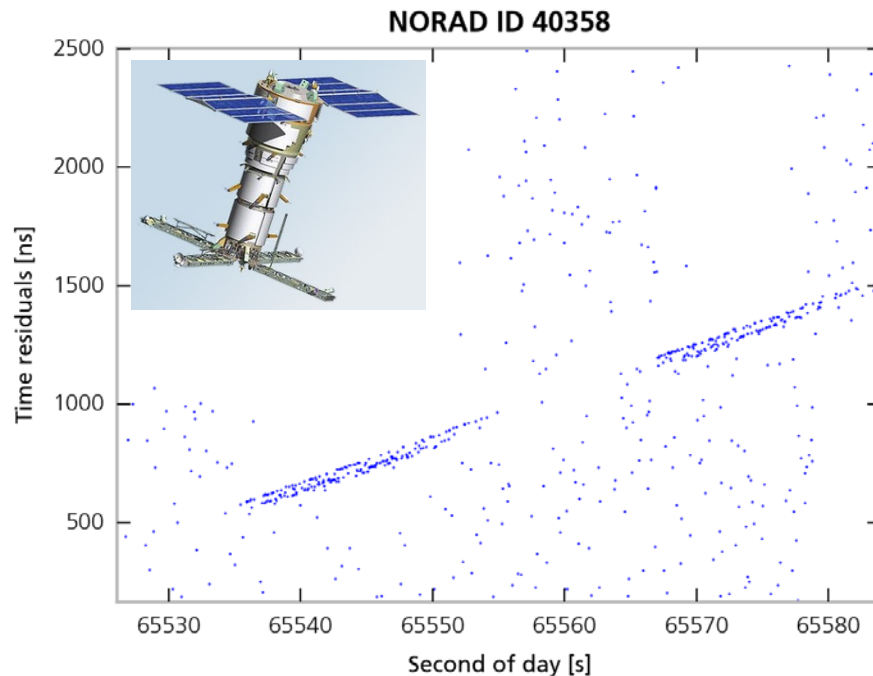
# Single Station Ranging (Wettzell)



Objects tracked	169
Successful	107 (60%)
Smallest Object	1.2m²@1200km (from DISCOS)



# Single Station Ranging (Wettzell)

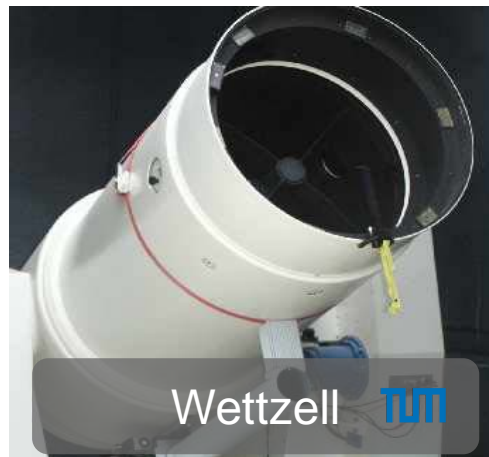
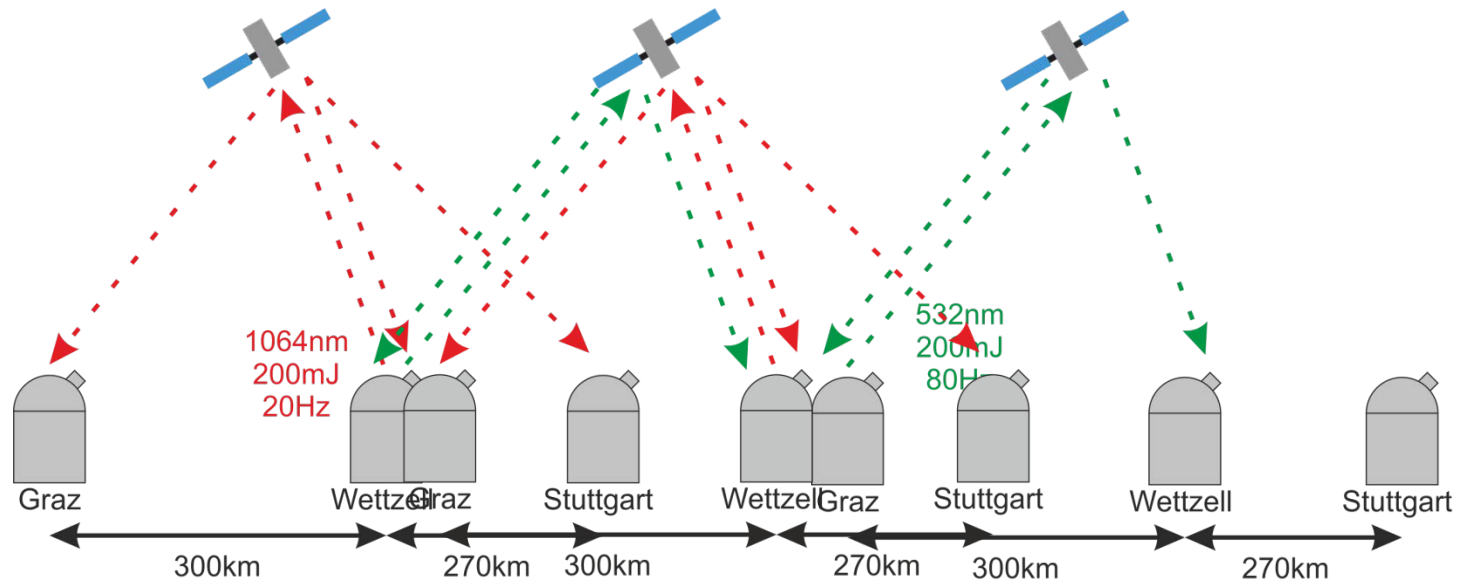


Laser ranging provides  
additional object information

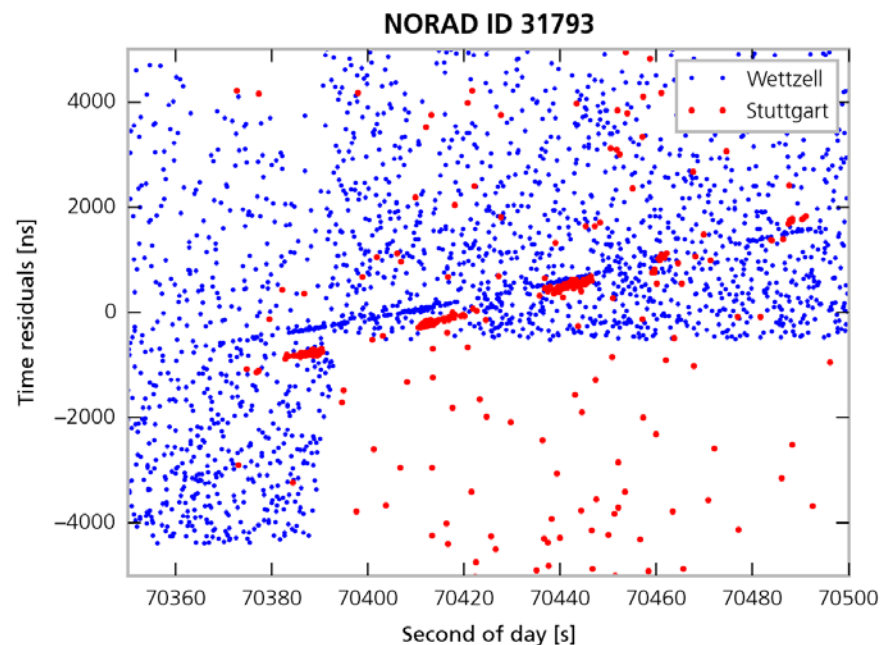
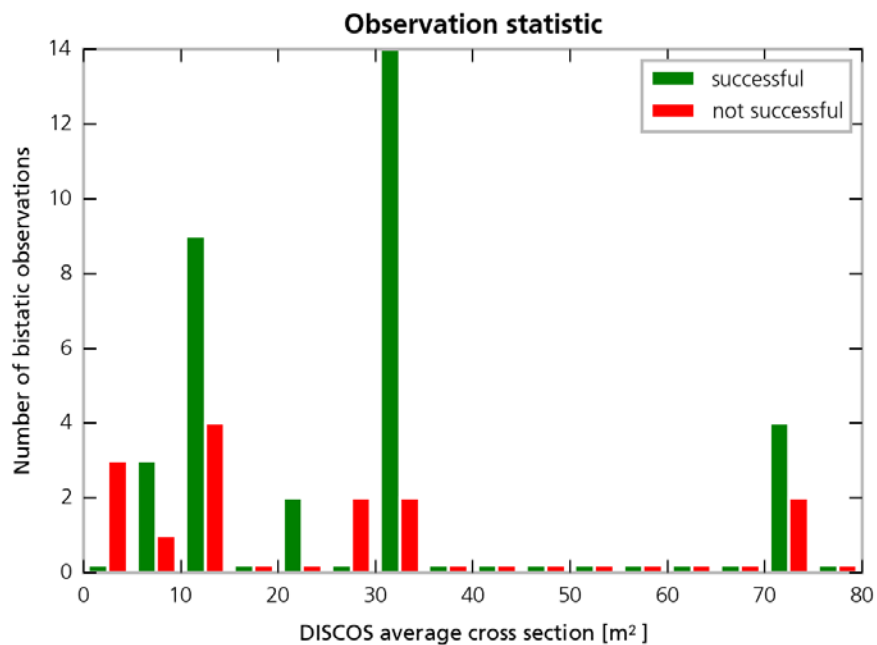




# Multistatic Ranging Configuration



# Bistatic Results 1064nm



	Stuttgart	Graz
Objects tracked	84	32
Successful Wettzell (single station)	51 (60%)	23 (72%)
Successful bistatic	36 (70%)	13 (56%)



# Further Steps

- Analyze tristatic measurements.
- First multi-color ranging conducted. Performing further measurements.

	1064	532	Already tested?
Graz	R	T/R	yes
Wettzell	T/R	R	no
Wettzell	T/R	T/R	first test

- Calculate and evaluate orbits from ranging data.
  - more information in talk of C.Bamann



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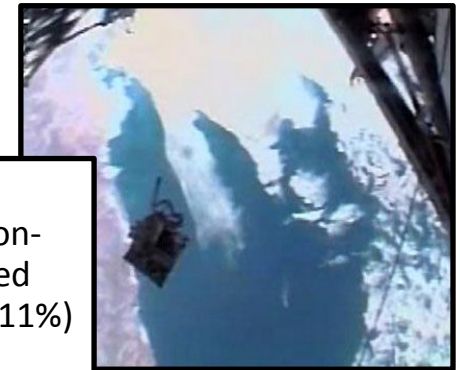
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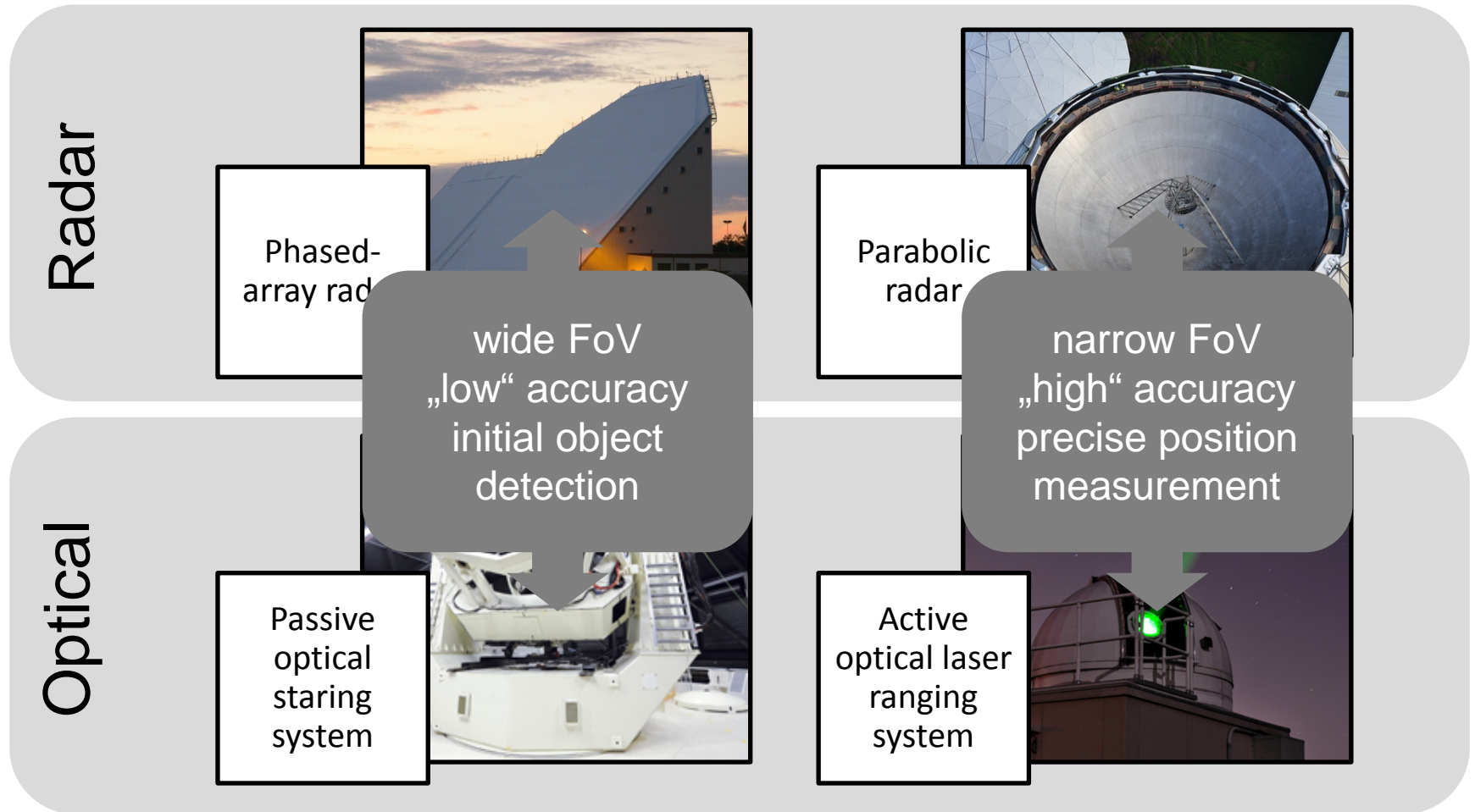
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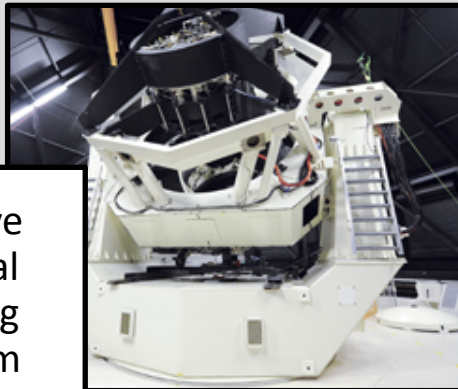
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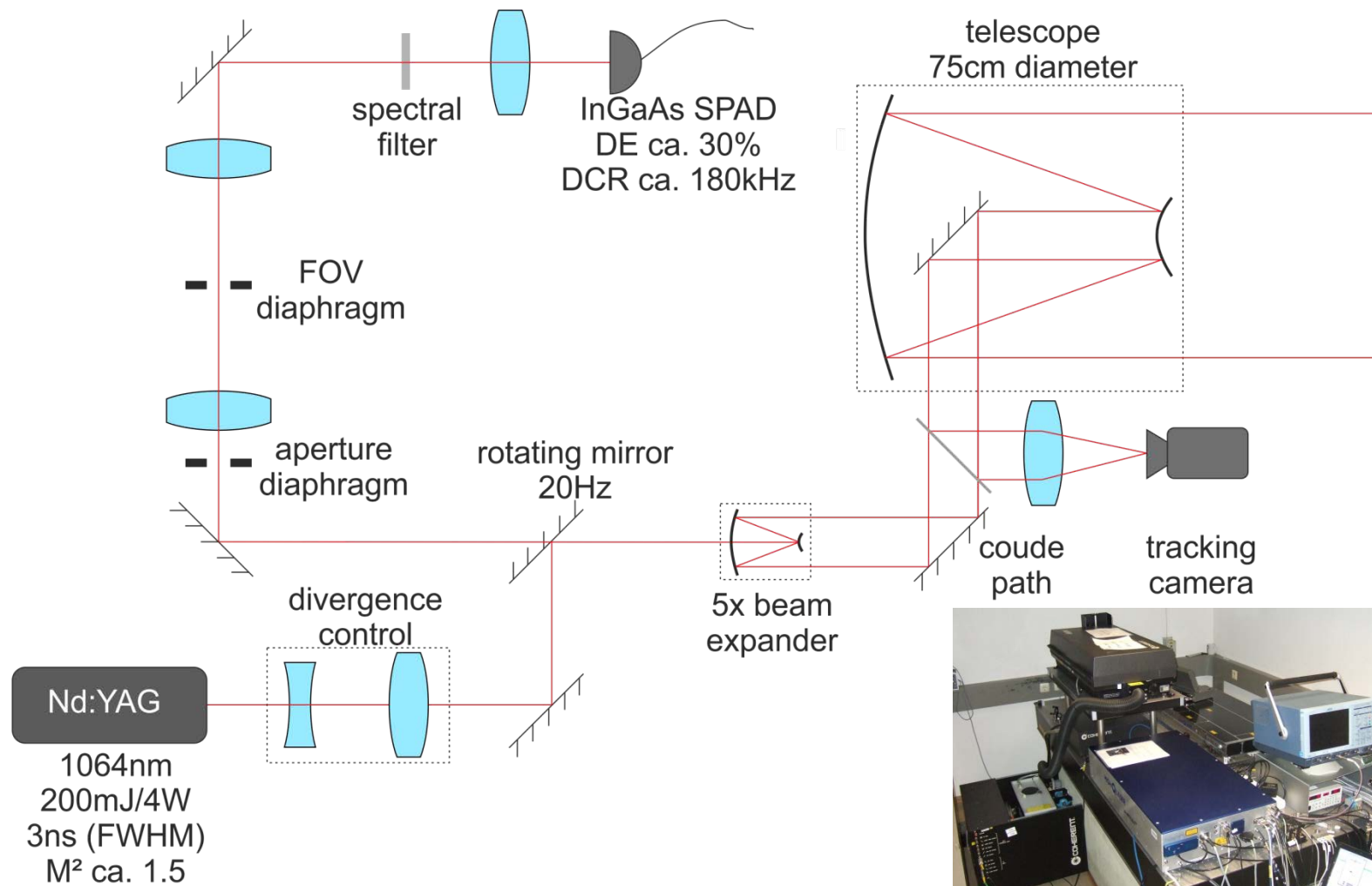


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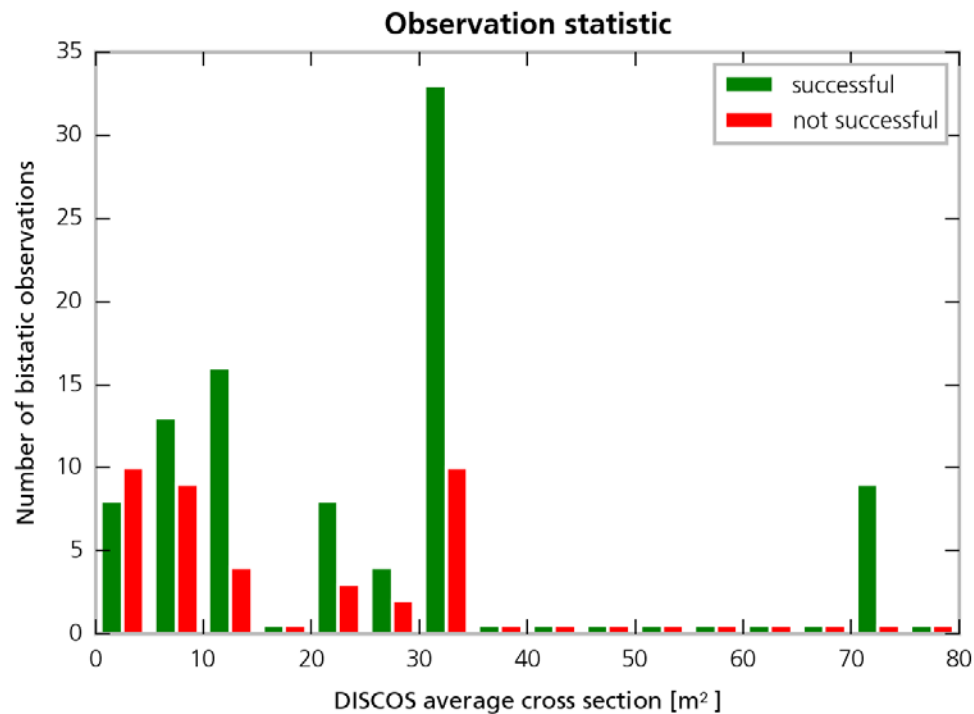


# Upgrade Wettzell SLR Station to DLR Station





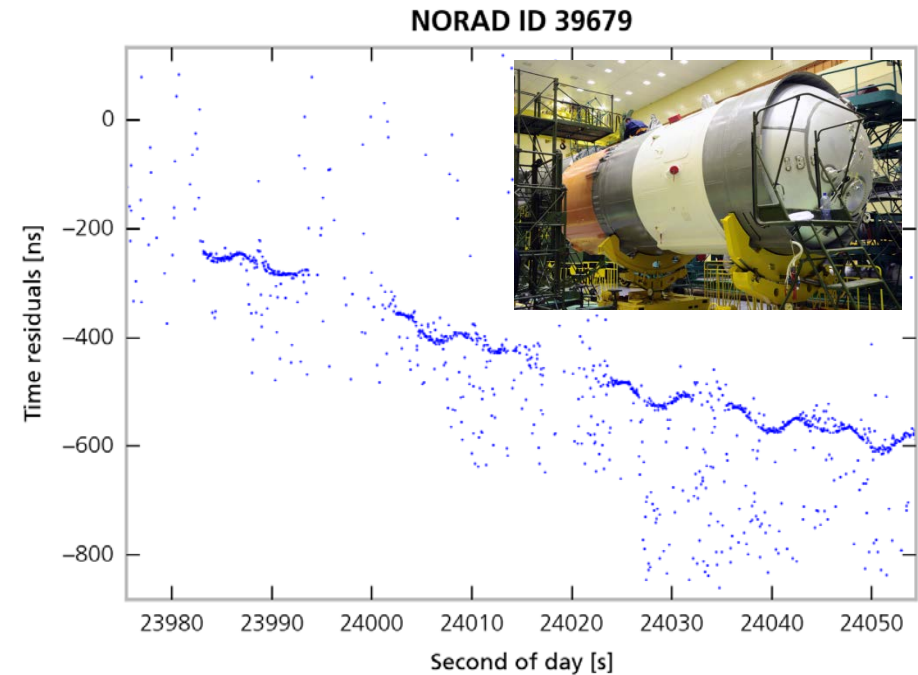
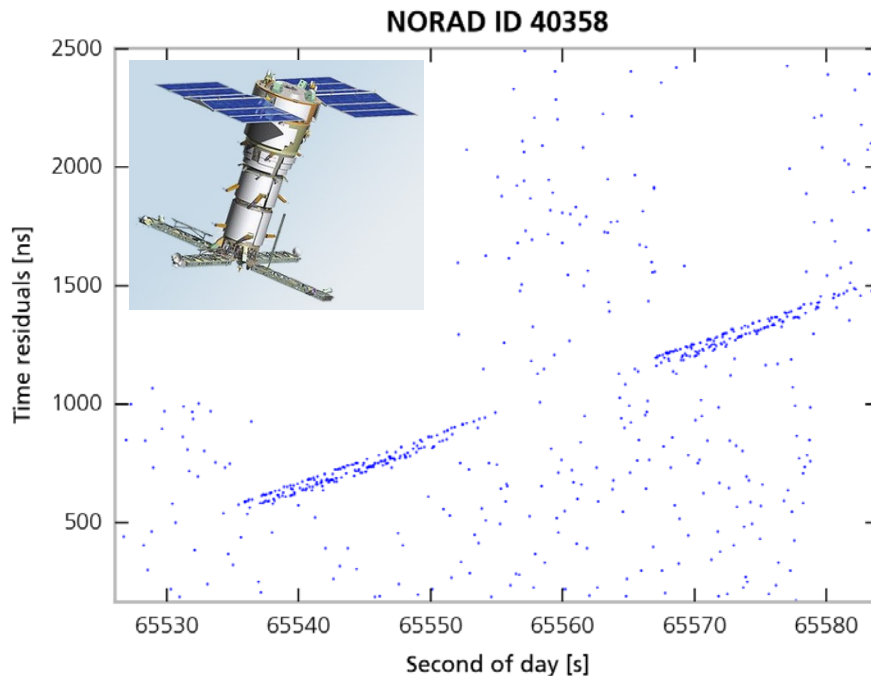
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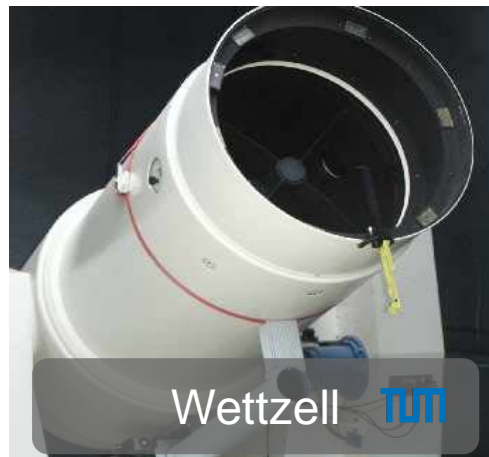
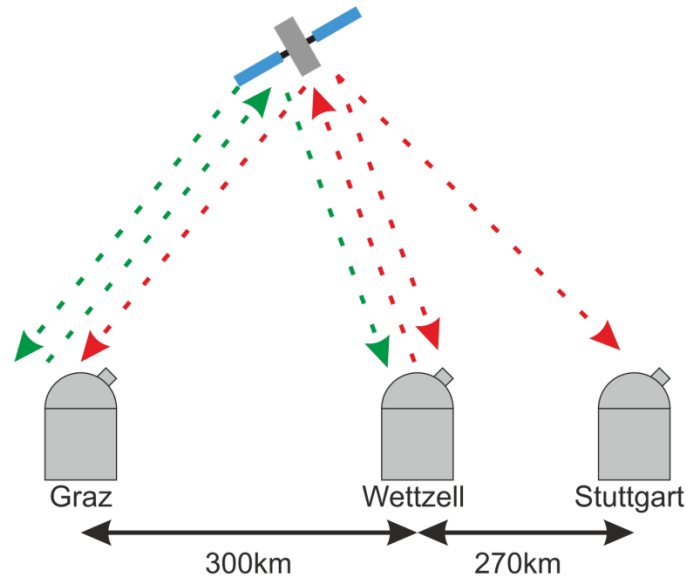
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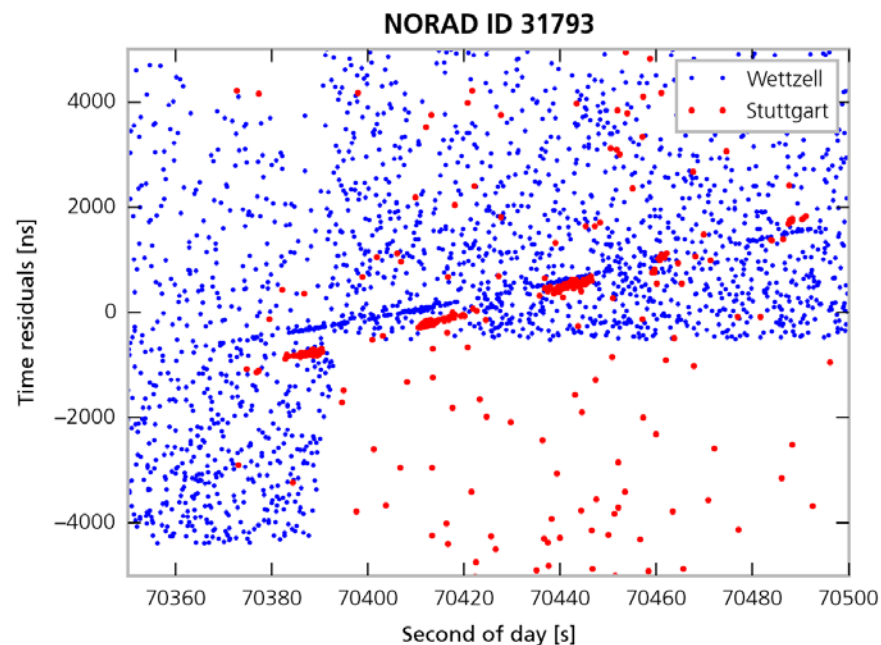
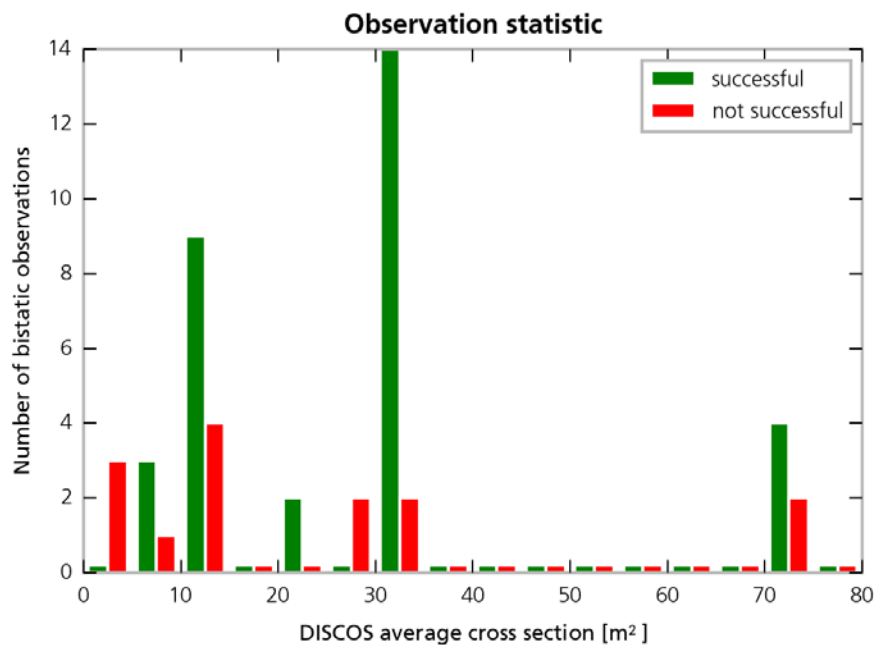
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